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APOLLO PROGRAM DIRECTIVE NO. 6

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SUBJECT: Sequence and Flow of Hardware Development and Key Inspection, Review and Certification Checkpoints

REFERENCES:
a) NPC 500-1
b) NPC 500-5
c) NPC 500-10
d) NPC 200 series
e) Design Certification Review - Program Directive No. 7 (M-D MA 1400.007)
f) Flight Readiness Review - Program Directive No. 8 (M-D MA 2210.008)

I. PURPOSE

The purpose of this directive is to define the reviews, inspections and certifications which are key checkpoints for the Apollo Program. These checkpoints are oriented to the hardware development and mission phases of the Program. The basic management principle for requiring these reviews, inspections and certifications is to insure that, at appropriate and progressive points in the program life cycle, sufficient visibility is obtained of the status of design, manufacture and testing to adequately determine the integrity of the system prior to mission accomplishment.

II. SCOPE

The six key checkpoints are:

1. PDR - Preliminary Design Review
2. CDR - Critical Design Review
3. FACI - First Article Configuration Inspection
4. COFW - Certification of Flight Worthiness
5. DCR - Design Certification Review
6. FRR - Flight Readiness Review

The PDR, CDR, FACI, and COFW are accomplished at an end item level. The DCR applies to the total space vehicle and FRR encompasses the total system. Progression through each checkpoint is dependent on the availability of documentation and hardware upon which to conduct the reviews, inspections, and certifications to insure that each checkpoint provides a more comprehensive assessment of program accomplishment. (See Figure 1.)

The PDR is a technical review of the basic design approach and is conducted prior to, or very early in, the detail design phase. The CDR is a technical review of specifications and drawings conducted, ideally, prior to release of drawings for manufacture. However, in those cases wherein a PDR and CDR have not been accomplished, management emphasis will be directed to the conduct of the FACI. The FACI is an examination of a selected (earliest possible) manufactured end item against the specification requirements, and released engineering drawings, and validates the acceptance testing. It may be necessary to reconduct the inspection, one or more times to insure that the contractor has corrected deficiencies identified at the first inspection. These inspections will result in the establishment of a firm baseline of specifications and drawings. Additionally, a FACI should be conducted on each major configuration departure from the basic hardware definition. Subsequent to FACI all end items will be accepted on a DD-250 subject to all the requirements of acceptance contained in the specification and NPC 500-1. The COFW certifies that each flight stage and module is a complete and qualified item of hardware prior to shipment and is accompanied by adequate supporting documentation. The DCR certifies the design of the total space vehicle, and FRR validates that the total system is operationally ready.

The ATR, NPC-500-10; the QA&R Program Plan, NPC 500-5; and NPC 200 series documents contain general requirements for test, reliability and quality assurance. To the extent these requirements affect or pertain to Contract End Items, they should be reflected in the appropriate sections of the Contract End Item Specs. Parts I & II prepared to satisfy the requirements of NPC-500-1. The specification will then contain all the technical requirements imposed by APO documents and will serve, along with the drawing structure, as the primary document against which reviews, inspections and certificates will be accomplished.

It is recognized that it may be desirable from the Program Managers' viewpoint to conduct additional reviews, inspections and certifications

to validate the compatibility of the Specifications, Drawings, Hardware and Test Results. Summaries of each of the above inspections, reviews and certifications are contained in Section III. Further detail for each is identified in the NPC 500-1, NPC 500-10 and program directives for the Design Certification Review and the Program Directors Flight Readiness Review.

III. PROCEDURES

A. PDR - Preliminary Design Review

The purpose of a PDR is to formally review the design approach of a Contract End Item prior to, or very early in, the detail design phase.

The PDR establishes:

1. The compatibility of the selected design approach for the Contract End Item with the Contract End Item Spec. Part I.

2. The system compatibility of the design approach by reference to predesign drawings, schematic diagrams, layout and envelope drawings, etc.

3. The integrity of the design approach by review of analyses, breadboard models, mockups, circuit logic diagrams, packaging techniques, etc.

4. The identification of the portions of the selected design approach to be subjected to detailed value engineering analysis.

5. The producibility of the selected design approach by review of requirements for special tools and facilities.

The detail requirements are covered in NPC 500-1.

B. CDR - Critical Design Review

The purpose of a CDR is to formally review the design of a Contract End Item when the design is essentially complete and is intended to precede the release of engineering for manufacture. The CDR establishes:

1. The compatibility of the Contract End Item as designed with the Contract End Item Spec. Part I.

2. The system compatibility of the completed design by reference to ICD's, schematics and functional block diagrams.

3. The integrity of the design by review of analytical and test data, and reliability apportionment and analysis available at that particular point in time.

The detail requirements are covered in NPC 500-1.

C. FACI - First Article Configuration Inspection

The purpose of the FACI is to establish the Product Configuration Baseline for the Contract End Item. It is accomplished by establishing the exact relationship of the Contract End Item as described by released engineering to the Contract End Item as manufactured and assembled. The products of a FACI include:

1. Acceptance of Part II of the Contract End Item Spec.

2. Validation of acceptance testing.

3. Comparison of the configuration of the end item unit undergoing First Article Configuration Inspection with the end item unit qualified or undergoing qualification if they are not the same unit.

4. Documented DD-250 indicating shortages and deficiencies which must be resolved prior to the FRR.

The detail requirements are covered in NPC 500-1.

D. COFW - Certification of Flight Worthiness

The purpose of the COFW checkpoint is to certify that each flight stage and module is a complete and qualified item of hardware prior to shipment and is accompanied by adequate supporting documentation. The COFW procedure informs the Apollo Program Director of any deficiencies prior to shipment from the manufacturing site and from the static firing site.

The COFW certifies that:

1. Specs and drawings have been developed in accordance with NPC 500-1; Section 3, NPC 250-1 and Section 4.2, NPC 200-2. Additionally the exact relationship of the Contract End Item as described by released engineering to the Contract End Item as manufactured and assembled has been established and that shortages which must be resolved prior to FRR have been indicated on a documented DD-250.

2. Acceptance, qualification and reliability demonstration tests have been successfully completed and meet the specification requirements.

3. Departures from specification and drawing requirements have been approved by Material Review Boards in accordance with NPC 200-2, Section 8.1.

4. Critical hardware failures have been analyzed and corrected in accordance with NPC 250-1, Section 3.7.

5. Hardware qualification program is in accordance with NPC 200-2, Sections 7.3, 7.4, 12, 14.2.

6. Hardware is complete and in accordance with the Narrative End Item Report in accordance with NPC 200-2. Section 14.2.4.

7. Data for operation and checkout is complete and compatible.

8. Shipping requirements of NPC 200-2, Section 11.6 have been met.

NOTE: FACI & DD-250 data requirements applicable to the COFW shall be used for the COFW. Detail requirements for COFW are contained in NPC 500-10.

E. DCR - Design Certification Review

The purpose of the DCR checkpoint is to certify the design of the total space vehicle system for flight worthiness and manned flight safety by a thorough formal review of the development and

qualification of all stages and modules and their installed subsystems. The review is to be conducted for the first manned Apollo-Saturn IB and Apollo-Saturn V space vehicle configurations.

Documents to be reviewed at the DCR for each subsystem, launch vehicle and spacecraft shall include the following:

1. Development Test Status

2. Qualification Test Status

3. Reference to applicable specification and qualification test reports showing that item has met specification requirements.

4. Summary of Test Failures and Dispositions.

5. List of actions remaining to complete qualification and definite plans for completing same.

6. Statement of apportioned reliability goal and comparable predicted reliability, including a discussion of the basis for the prediction.

7. Statement to be signed by the cognizant NASA and Contractor personnel certifying that the item covered is qualified for manned flight.

NOTE: FACI, COFW, & DD-250 data requirements applicable to the DCR shall be used for the DCR.

F. FRR- Flight Readiness Review

The FRR will be a two part review, scheduled for each mission by a joint letter signed by the Program Director and the Mission Director. Upon completion of a satisfactory FRR the Mission Period will commence.

PART I - PROGRAM DIRECTOR

The purpose of the Program Director's FRR checkpoint is to determine that the space vehicle hardware and launch complex

are ready to commence the mission period. This determination involves the review of:

1. Mission Directive Synopsis

2. Launch Vehicle Readiness Assessment

3. Spacecraft Readiness Assessment

4. Launch Site Readiness Assessment

5. Updated Mission Rules Review and Concurrence

Additionally, the following items may be considered for review at this time.

1. The checkout and qualification test status of all hardware, and that the system is flight worthy and meets the requirements for manned safety.

2. The summary of failures and the disposition of the failures, with particular emphasis on failures that have occurred during the pre-launch and checkout phase where records indicate a previous failure history.

3. All modifications, deviations and waivers. A certification that the space vehicle hardware end items are described by officially released engineering and that all required engineering changes after hardware delivery from the factory have been installed in the hardware.

PART II - MISSION DIRECTOR

The purpose of the Mission Director's FRR is to make a judgment for initiating the mission period and committing the deployment of world wide forces to support the mission. Typical areas encompassed by the review include the readiness posture of:

1. The Manned Space Flight Network

2. The flight control capabilities

3. The flight crews

4. The recovery planning

5. The medical planning

6. The Public Information planning

The review compares the status of major operational elements of the mission with requirements outlined in the Mission Operations Plan and the Support Requirements Planning Document which are developed in accordance with the PDP.

NOTE: FACI, COFW, and DCR data requirements applicable to the FRR shall be used for the FRR.

IV. RESPONSIBILITIES

The conduct of the PDR, CDR, FACI and COFW is the responsibility of the Center having development responsibility for the end item. The conduct of the DCR is the responsibility of the Associate Administrator for Manned Space Flight. The conduct of the FRR is the responsibility of the Apollo Program Director and the Mission Director of OMSF.

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SEQUENCE AND FLOW OF HARDWARE DEVELOPMENT AND KEY CHECKPOINTS

DESIGN	MANUFACTURE & C/O	STATIC FIRING & C/O	STAGE & MODULE & INTEGRATED TESTS (KSC)	MISSION PERIOD
FACTORY		SITE TESTING		

PDR CDR FACI COFW (Stages) DCR FRR
COFW (Stages & modules)

Key Review, Inspection, Certification Requirements

	SPEC.	DWGS	H. W.	TEST RESULTS	QUALITY & HIST. RECORDS	REL. STATEMENT	*FAILURE SUMMARY
PDR	PART I						
CDR	PART I	X					
FACI	PART II	X	X	X	X		
COFW	X	X	X	X	X		
DCR	X			X		X	X
FRR P. D.				X	X	X	X
FRR M. D.	Mission Readiness Validation						

*Summary of Test Failure & Dispositions

FIGURE